

AMENDMENTS TO THE CLAIMS

1. (Withdrawn) A method of processing fullerenes comprising ~~the steps of:~~

generating a first gas stream comprising suspended soot particles and condensable gases, said condensable gases comprising gaseous fullerenes, and

separating at least a portion of the suspended soot particles ~~condensable gases~~ from the condensable gases in the first gas stream to obtain a second gas stream reduced in soot content, suspended soot particles using a gas/solid separations process,

wherein said gaseous fullerenes are not condensed prior to said separating.

~~separation.~~
2. (Withdrawn) The method of claim 1, wherein the first gas stream ~~of suspended soot particles and condensable gases~~ is obtained using a method selected from the group consisting of combustion, arc plasma discharge, laser ablation, graphite burning, ~~and~~ negative ion/desorption chemical ionization, and combinations thereof.
3. (Withdrawn) The method of claim 1, wherein the first gas stream ~~of suspended soot particles and condensable gases~~ is obtained using a combustion device.
4. (Withdrawn) The method of claim 1, wherein said separating ~~the separations process~~ is conducted under conditions of ~~optimal~~ fullerene stability.
5. (Withdrawn) The method of claim 4, wherein said conditions of ~~optimal~~ fullerene stability comprise conditions where consumption of fullerenes by the suspended soot particles or other species contained in the first gas stream is minimized.

6. (Withdrawn) The method of claim 5, wherein the time-scale of said separating gas/solid separation is small relative to the time-scale of fullerene said consumption of fullerenes by the suspended soot particles or other species.
7. (Withdrawn) The method of claim 1, wherein gaseous fullerenes having a volatility lower than a selected volatility are separated with the suspended soot particles during said separating in the gas/solid separations process.
8. (Withdrawn) The method of claim 1, wherein the first gas stream has a residence time of between about 10 msec and about 10 sec upstream of the separations process prior to said separating separation.
9. (Withdrawn) The method of claim 1, wherein the first gas stream has a residence time of between about 100 msec and about 2 sec upstream of the separations process prior to said separating separation.
10. (Withdrawn) The method of claim 1, wherein the portion of condensable gases separated from the suspended soot particles in said second gas stream is enhanced in selected fullerene species to a greater extent than other fullerene species.
11. (Withdrawn) The method of claim 1, wherein the gas/solid separations process is a concentrator, said separating comprises producing a first fraction and a second fraction of the second gas stream, and the concentration of the suspended soot particles in the first fraction is higher percentage gas effluent stream with respect to than the concentration of the suspended soot particles in the second fraction, and a lower percentage gas effluent stream with respect to suspended soot.

12. (Withdrawn) The method of claim 1, wherein ~~the separation of at least a portion of the condensable gases from the soot particles~~ said separating is accomplished at a temperature of less than about 1100 °C.

13. (Withdrawn) The method of claim 1, wherein ~~the separation of at least a portion of the condensable gases from the soot particles~~ said separating is accomplished at a temperature in the range of about 300 °C to about 2000 °C.

14. (Withdrawn) The method of claim 1, wherein ~~the separation of at least a portion of the condensable gases from the soot particles~~ said separating is accomplished at a temperature in the range of about 300 °C to about 900 °C.

15. (Withdrawn) The method of claim 1, further comprising:

condensing at least a portion of the gaseous fullerenes in the ~~condensable gases~~
~~after separation of the condensable gases~~ second gas stream to obtain condensed fullerenes.

16. (Withdrawn) The method of claim 15, wherein the condensed fullerenes form as suspended fullerene particles.

17. (Withdrawn) The method of claim 16, wherein the condensed fullerenes condense by heterogeneous nucleation and/or homogeneous nucleation, ~~in the gas stream which contains suspended seed particles.~~

18. (Withdrawn) The method of claim 15, wherein said condensing comprises nucleation and/or growth of particles ~~[[is]]~~ promoted by sonic, ionic, or radioactive methods.

19. (Withdrawn) The method of claim 17, wherein ~~said~~ seed particles for said heterogeneous nucleation comprise soot.

20. (Withdrawn) The method of claim 15, further comprising:

collecting the condensed fullerenes ~~in a separations process~~.

21. (Withdrawn) The method of claim 20, wherein ~~the separations process~~ said collecting comprises separating the condensed fullerenes from the second gas stream ~~a gas/solid separations process~~.

22. (Withdrawn) The method of claim 1 or 21, wherein said separating at least a portion of the suspend soot particles from the condensable gases in the first gas stream and said separating the condensed fullerenes from the second gas stream are carried out using a process independently ~~the gas/solids separations process~~ is selected from the group consisting of filtration, electrostatic precipitation, electrostatic separation, ~~and inertial separation,~~ and combinations thereof.

23. (Withdrawn) The method of claim 22, wherein ~~filtration is~~ said separating at least a portion of the suspend soot particles from the condensable gases in the first gas stream and said separating the condensed fullerenes from the second gas stream are carried out using a process independently selected from the group consisting of sieve filtration, fiber filtration, ~~and packed bed filtration,~~ and combinations thereof.

24. (Withdrawn) The method of claim 20, wherein said collecting comprises condensing the gaseous fullerenes and/or the condensed fullerenes onto a surface.

25. (Withdrawn) The method of claim 16, wherein the mean size of the suspended fullerenes particles ~~formed downstream of the gas/solid separation device~~ is in the range of 0.1 μm to 500 μm .

26. (Withdrawn) The method of claim 16, wherein the mean size of the suspended fullerenes particles ~~formed downstream of the gas/solid separation device~~ is in the range of 10 μm to 200 μm .
27. (Withdrawn) The method of claim 20, wherein the velocity of the second gas stream is maintained at a velocity selected to minimize losses of fullerenes to surfaces during conveyance of the second gas stream to a collection site.
28. (Withdrawn) The method of claim 1 or 15, wherein a diluent gas is added to the first gas stream and/or the second gas stream.
29. (Withdrawn) The method of claim 15, wherein ~~the step of~~ said condensing comprises condensing a first selected fullerene species or a first set of selected fullerene species.
30. (Withdrawn) The method of ~~claim 1~~, claim 29, further comprising:

collecting the condensed first condensed selected fullerene species or the condensed first set of selected fullerene species in a separations process.
31. (Withdrawn) The method of ~~claim 1~~, claim 30, wherein ~~the separations process is~~ said collecting the condensed first selected fullerene species or the condensed first set of selected fullerene species comprises a gas/solid separations process.
32. (Withdrawn) The method of ~~claim 1~~, claim 31, further comprising:

condensing a second selected fullerene species or a second set of selected fullerene species after said condensing condensation of the first selected fullerene species or the first set of selected fullerene species.
33. (Withdrawn) The method of claim 32, further comprising:

collecting the condensed second selected fullerene species or the condensed second set of selected fullerene species in a subsequent separations process.

34. (Withdrawn) The method of claim 33, wherein said collecting the condensed second selected fullerene species or the condensed second set of fullerene species comprises the separations process is a second gas/solid separations process.

35. (Withdrawn) The method of claim 15, wherein the temperature of the second gas stream is in the range of about minus 250° C to 1200° C.

36. (Withdrawn) The method of claim 15, wherein the temperature of the second gas stream is in the range of about 100° C to 800° C.

37. (Withdrawn) The method of claim 1, ~~wherein~~ further comprising: maintaining conditions are maintained in a reaction zone subsequent to said separating downstream of the gas/solid separations process to promote additional fullerene formation in the second gas stream.

38. (Withdrawn) The method of claim 37, wherein additional suspended soot particles are formed in the second gas stream as a by-product of the additional fullerene formation, a second gas/solid separation process is carried out after the formation of fullerenes in the reaction zone said method further comprising separating to separate at least a portion of the additional suspended soot particles from the second gas stream formed as a by-product of the additional fullerene formation.

39. (Withdrawn) The method of claim 37, wherein temperatures ~~downstream of the gas/solid separations process~~ in said reaction zone are maintained at about 500° C to 2200° C.

40. (Withdrawn) The method of claim 37, wherein temperatures ~~downstream of the gas/solid separations process~~ in said reaction zone are maintained at about 900° C to 1700° C.

41. (Withdrawn) The method of claim 20, ~~wherein condensation and collection of~~
further comprising condensing and collecting non-fullerene condensable species is accomplished
subsequent to said collecting the condensed fullerenes ~~collection of the fullerene species.~~

42. (Withdrawn) The method of claim 41 wherein the non-fullerene condensable
species comprises polycyclic aromatic hydrocarbons.

43. (Withdrawn) The method of claim 38, further comprising:

condensing at least a portion of the fullerenes from the condensable gases after
said separating at least a portion of the additional suspended soot particles from the second gas
stream ~~the second gas/solid separations process; and~~

collecting the condensed fullerenes ~~in a separations process.~~

44. (Withdrawn) The method of claim 1 or 20, wherein said separating the gas/solids
~~separation device~~ is operated in a steady mode.

45. (Withdrawn) The method of claim 1 or 20, wherein said separating the gas/solids
~~separation device~~ is operated in an un-steady mode.

46. (Withdrawn) The method of claim 15, ~~30, 32 or 37~~, wherein the percentage by
weight of fullerenes to soot and other condensables in the ~~collected~~ condensed fullerenes is in
the range of about 70% to 100%.

47. (Withdrawn) The method of claim 20, wherein the collected condensed
fullerenes are enriched in fullerenes as compared to the fullerene content of the first gas stream
~~prior to separation of the suspended soot from the gas stream.~~

48. (Withdrawn) The method of claim 15, wherein the ~~collected~~ condensed
fullerenes comprise about 10% to about 70% by weight fullerenes.

49. (Withdrawn) The method of claim 1 or 15, wherein temperature of the first gas stream and/or the second gas stream is controlled by ~~use of~~ conductively cooled surfaces, ~~and/or~~ inert gases, ~~and/or~~ heat absorption by phase change, or combinations thereof.

50. (Withdrawn) The method claim 1 or 20, wherein residence time of said separating in the gas/solids separation process is controlled by addition of an inert gas.

51. (Currently Amended) A method for processing fullerenes comprising ~~the steps of:~~

burning a carbon-containing fuel under conditions effective to produce fullerenes and to generate ~~an effluent~~ a first gas stream comprising suspended soot particles and condensable gases, said condensable gases comprising gaseous fullerenes; and

separating at least a portion of ~~the condensable gases from~~ the suspended soot particles from the condensable gases in the first gas stream to obtain a second gas stream reduced in soot content. ~~using a gas/solid separations process.~~

52. (Currently Amended) The method of claim 51, wherein said separating the separation of at least a portion of the condensable gases from the soot particles is accomplished at a temperature less than about 1100 °C.

53. (Currently Amended) The method of claim 51, wherein ~~the separation of at least a portion of the condensable gases from the soot particles~~ said separating is accomplished at a temperature in the range of about 300 °C to about 900 °C.

54. (Currently Amended) The method of claim 51, wherein ~~the gas/solid separations~~ said separating is conducted under conditions of ~~optimal~~ fullerene stability.

55. (Currently Amended) The method of claim 54, wherein said conditions of ~~optimal~~ fullerene stability comprise conditions where consumption of fullerenes by the suspended soot particles or other species contained in the first gas stream is minimized.

56. (Currently Amended) The method of claim 55, wherein the time-scale of said separating gas/solid separation is small relative to the time-scale of ~~fullerene~~ said consumption of fullerenes by the suspended soot particles or other species or embedding.

57. (Currently Amended) The method of claim 51, wherein the first gas stream has a residence time of between about 10 msec and about 10 sec ~~upstream of the separations process prior to separation.~~

58. (Currently Amended) The method of claim 51, wherein the first gas stream has a residence time of between about 100 msec and about 2 sec ~~upstream of the separations process prior to separation.~~

59. (Currently Amended) The method of claim 51, wherein ~~the gas/solid separations process is a concentrator,~~ said separating comprises producing a first fraction and a second fraction of the second gas stream, and the concentration of the suspended soot particles in the first fraction is higher percentage gas effluent stream with respect to than the concentration of the suspended soot particles in the second fraction, and a lower percentage gas effluent stream with respect to suspended soot.

60. (Currently Amended) The method of claim 51, wherein ~~the gas/solids separations process~~ said separating is carried out using a process selected from the group consisting of filtration, electrostatic precipitation, electrostatic separation, and inertial separation, and combinations thereof.

61. (Currently Amended) The method of claim 60, wherein ~~filtration~~ said separating is carried out using a process selected from the group consisting of sieve filtration, fiber filtration, ~~and~~ packed bed filtration, and combinations thereof.

62. (Currently Amended) The method of claim 60, wherein ~~filtration~~ said separating is accomplished ~~by the use of~~ utilizing a ceramic particulate filter.

63. (Original) The method of claim 62, wherein the ceramic particulate filter contains a catalyst to promote thermal regeneration of the filter to remove collected soot.

64. (Currently Amended) The method of claim 63, wherein the ceramic particulate filter is selected from the group consisting of cordierite, silicon carbide, alumina, ~~and~~ alumina/silica compositions, and combinations thereof.

65. (Original) The method of claim 63, wherein the catalyst is a metal.

66. (Currently Amended) The method of claim 51, wherein ~~the gas/solid separation~~ said separating is conducted at a time and location selected to ~~provide~~ separate suspended soot particles that have an average particle size in the range of 0.1 μm – 100 μm .

67. (Currently Amended) The method of claim 51, wherein ~~the gas/solid separation~~ said separating is conducted at a time and location selected to ~~provide~~ separate suspended soot particles that are collectable on a filter having a mean effective pore size in the range of about 0.1 – 100 μm .

68. (Currently Amended) The method of claim 51, further comprising:

condensing at least a portion of the gaseous fullerenes in the condensable gases after said separating ~~separation of the condensable gases from the suspended soot~~.

69. (Currently Amended) The method of claim 68, wherein the condensed fullerenes ~~form~~ condense as suspended fullerene particles.

70. (Currently Amended) The method of claim 69, wherein the condensed fullerenes condense by heterogeneous nucleation and/or homogeneous nucleation, ~~in the gas stream which contains suspended seed particles.~~

71. (Currently Amended) The method of claim 70, wherein ~~said seed particle~~ comprises particles for heterogeneous nucleation comprise soot.

72. (Currently Amended) The method of claim 68, further comprising:
collecting the condensed fullerenes ~~in a separations process.~~

73. (Original) The method of claim 72, wherein the percentage by weight of fullerenes to soot and other condensables in the collected condensed fullerenes is in the range of about 70% to 100%.

74. (Currently Amended) The method of claim 72, wherein the collected condensed fullerenes is enriched in fullerenes as compared to the fullerene content of the first gas stream ~~prior to separation of the suspended soot from the gas stream.~~

75. (Original) The method of claim 72, wherein the collected condensed fullerenes comprise about 10% to about 70% by weight fullerenes.

76. (Currently Amended) The method of claim 69, wherein the mean size of the suspended fullerene particles ~~formed downstream of the gas-solid separation device~~ is in the range of 0.1 μm to 500 μm .

77. (Currently Amended) The method of claim 69, wherein the mean size of the suspended fullerene particles formed downstream of the gas solid separation device is in the range of 10 μm to 200 μm .

78. (Currently Amended) The method of claim 72, wherein ~~the separations process~~ said collecting the condensed fullerenes comprises separating the condensed fullerenes from the second gas stream ~~a gas/solid separations process~~.

79. (Currently Amended) The method of claim 78, wherein ~~the gas/solids separations process~~ said separating the condensed fullerenes from the second gas stream is carried out using a process selected from the group consisting of filtration, electrostatic precipitation, inertial separation, ~~and electrostatic separation, and combinations thereof~~.

80. (Currently Amended) The method of claim 79, wherein ~~filtration~~ said separating the condensed fullerenes from the second gas stream is carried out using a process selected from the group consisting of sieve filtration, fiber filtration, ~~and packed bed filtration, and combinations thereof~~.

81. (Currently Amended) The method of claim 68, wherein the second gas stream comprises nucleation sites to promote the condensation of the gaseous fullerenes ~~from the gas stream~~.

82. (Original) The method of claim 81, wherein the nucleation sites comprise soot particles, or other suspended particles having a particle size in the range of about 0.01 μm – 100 μm .

83. (Currently Amended) The method of claim 51, further comprising:

condensing at least a portion of a non-fullerene species in the condensable gases
after said separating ~~separation of the condensable gases from the suspended soot~~; and
collecting the condensed non-fullerene species ~~in a separations operation~~.

84. (Currently Amended) The method of claim 83, wherein ~~the condensation~~ said
condensing is carried out at a temperature in the range of about negative 250 °C to about 600 °C.

85. (Currently Amended) The method of claim 51 or 68, wherein temperature of the
first gas stream and/or second gas stream is controlled by ~~use of~~ conductively cooled surfaces,
and/or inert gases, and/or heat absorption by phase change.

86. (Currently Amended) The method claim 51 or 68, wherein residence time ~~in the~~
~~gas/solids separation process~~ of said separating is controlled by addition of an inert gas.

87. (Original) The method of claim 20 or 72, wherein the collected condensed
fullerenes are substantially free of polycyclic aromatic hydrocarbons (PAH).

88. (Original) The method of claim 20 or 72, wherein the collected condensed
fullerenes are substantially free of soot.

89. (Currently Amended) The method of claim 87, wherein the polycyclic aromatic
hydrocarbon (PAH) content of the condensable gases is reduced by reacting of the PAH with the
suspended soot particles.

90. (Currently Amended) The method of claim 1 or 51, further comprising ~~the step~~
~~of~~:

during or after said separating, ~~separation of the soot from the condensable gases~~
~~of the effluent gas~~, introducing an oxidative species ~~into the gas/solids separation process~~ at
temperatures that allow for oxidation of the ~~collected~~ separated soot.

91. (Currently Amended) A method for processing fullerenes, comprising ~~the steps of:~~

burning a carbon-containing fuel in a flame under conditions effective to produce fullerenes and to generate ~~an effluent~~ a first gas stream comprising suspended soot particles and condensable gases, said condensable gases comprising gaseous fullerenes;

~~separating at least a portion of the condensable gases from the suspended soot particles from the condensable gases in the first gas stream using a gas/solid separations process to obtain condensable gases~~ a second gas stream reduced in soot content; and

introducing the second gas stream ~~condensable gases comprising fullerenes~~ into a subsequent location where further treatment or reaction of the gaseous fullerenes is conducted.

92. (Currently Amended) The method of claim 91, wherein the ~~condensable gases comprising fullerenes are~~ second gas stream is condensed to provide at least a portion of the fullerenes as suspended fullerene particles in the second gas stream ~~condensable gases~~, and the suspended fullerene particles are introduced into the subsequent location.

93. (Canceled).

94. (Withdrawn) An apparatus for the processing of fullerenes comprising:

a gas effluent source capable of generating a gas effluent comprising suspended soot particles and condensable gases, said condensable gases comprising fullerenes;

an inlet conduit for directing a gaseous effluent to a first separation point;

a first gas/solid separation device located at the first separation point;

an outlet conduit for directing a gas effluent from the first separation point to a first collection point;

a collection device located at the first collection point; and

a temperature control for controlling the temperature of the gaseous effluent.

95. (Withdrawn) The apparatus of claim 94, wherein the temperature control comprises use of conductively cooled surfaces and/or inert gases and/or heat absorption by phase change.

96. (Withdrawn) The apparatus of claim 94, wherein the apparatus comprises a plurality of gas/solid separation devices and/or gas/solid collection devices.

97. (Withdrawn) The apparatus of claim 94, wherein the separation device is selected from the group consisting of filters, electrostatic precipitators, electrostatic separators, and inertial separators.

98. (Withdrawn) The apparatus of claim 97, wherein the filter comprises a sieve filter.

99. (Withdrawn) The apparatus of claim 97, wherein the filter comprises high temperature alumina beads.

100. (Withdrawn) The apparatus of claim 94, wherein the apparatus comprises a plurality of collection devices.

101. (Withdrawn) The apparatus of claim 94, wherein the collection device comprises a condensing surface.

102. (Withdrawn) The apparatus of claim 94, wherein the collection device is selected from the group consisting of [[of]] filters, electrostatic precipitators, electrostatic separators, and inertial separators.

103. (Withdrawn) The apparatus of claim 94, further comprising:

first and second gas/solid separation devices, each said device in flow communication with the inlet conduit;

means for directing the gases from the inlet conduit into the first or second gas/solid separations devices; and

first and second outlets for directing gas effluent from the first and second gas/solid separation devices, respectively.

104. (Withdrawn) The apparatus of claim 103, further comprising:

a first inlet port for introducing material into the first gas/solids separation device;
and

a second inlet port for introducing material into the second gas/solids separation device.

105. (Withdrawn) An apparatus for the processing of fullerenes comprising:

means for generating and directing a gaseous effluent comprising suspended soot particles and condensable gases from a gaseous effluent source to a first collection point;

means for separating a first solid from the gaseous effluent at a first collection point;

means for directing the gas stream from the first collection point to a second collection point;

means for separating a second solid from the gaseous effluent at a second collection point; and

temperature control means for controlling the temperature of the gaseous effluent.

106. (Withdrawn) A method of cleaning a gas/solids separations device comprising a filter, comprising:

during or after separation of soot from a carrier gas and collection of the soot on a filter, contacting the filter with an oxidative species at a temperature that oxidizes the collected soot.

107. (Withdrawn) The method of claim 106, wherein the filter is a packed bed filter.

108. (Withdrawn) The method of claim 106, wherein the filter is a ceramic particulate filter.

109. (Withdrawn) The method of claim 106, wherein the filter comprises high temperature alumina particles.

110. (Withdrawn) The method of claim 106, wherein the oxidative species comprises air.

111. (Withdrawn) The method of claim 106, whereby an inert gas is added to the effluent gases of the thermal regeneration so as to reduce the temperature sufficiently that reaction of fullerenes collected downstream of the thermal regeneration does not occur.

112. (Withdrawn) The method of claim 106, whereby the effluent gases of the thermal regeneration are by-passed and do not contact fullerenes collected downstream so that reaction does not occur.

113. (Withdrawn) The method of claim 106, wherein the filter comprises a catalyst for the oxidation of soot.

114. (Withdrawn) The method of claim 106, wherein soot oxidation occurs concurrent with the separation of soot from the carrier gas.

115. (Withdrawn) The method of claim 114, wherein the oxidative species is introduced at or immediately prior to the soot filter.

116. (Withdrawn) A method of fullerene recovery from soot, comprising:

generating a gas stream comprising suspended soot particles and condensable gases, said condensable gases comprising gaseous fullerenes;

separating at least a portion of the condensable gases from the suspended soot particles using a filter;

during or after separation and collection of soot from the condensable gases on a filter, contacting the filter with an oxidative species at a temperature that oxidizes the collected soot; and

condensing and collecting fullerenes from the condensable gases downstream from the soot filter.

117. (Withdrawn) A method of processing fullerenes comprising ~~the steps of:~~

generating a gas stream comprising suspended soot particles and condensable gases, said condensable gases comprising gaseous fullerenes;

condensing at least a portion of the condensable gases;

collecting the suspended soot particles and condensed condensable gases at a collection location;

heating the collected soot and condensed condensable gases to sublime at least a fullerene species; and

condensing the sublimed fullerene species.

118. (Withdrawn) The method of claim 117, wherein the suspended soot particles and condensed condensable gases are collected on a filter and are sublimed using heated inert gases.

119. (Withdrawn) The method of claim 117, wherein the suspended soot particles and condensed condensable gases are collected on a filter and are sublimed in a combustion device operated in non-sooting conditions.

120. (Withdrwawn) A method of processing fullerenes comprising ~~the steps of:~~

generating a first gas stream comprising suspended soot particles and condensable gases, said condensable gases comprising gaseous fullerenes,

separating at least a portion of ~~the condensable gases from~~ the suspended soot particles from the first gas stream to obtain a second gas stream comprising said gaseous fullerene; using a gas/solid separations process;

condensing at least a portion of the fullerenes in the second gas stream ~~condensable gases after separation of at least a portion of the condensable gases from soot;~~ and

collecting the condensed fullerenes.

121. (Withdrawn) The method of claim 120, further comprising:

heating the collected fullerenes to sublime at least a fullerene species; and

condensing the sublimed fullerene species.

122. (Currently Amended) A method of processing fullerenes comprising ~~the steps of:~~

generating a first gas stream comprising suspended soot particles and
condensable gases, said condensable gases comprising gaseous fullerenes, and
separating at least a portion of the ~~eondensable gases from the~~ suspended soot
particles from the condensable gases in the first gas stream to obtain a second gas stream
reduced in soot content. ~~using a gas/solid separations process.~~